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The visual acuity of 100 patients between the ages of 16 and 66 years, seen for routine ophthalmologic examination, was measured before and after dilation. All patients had a predilation visual acuity of 20/40 or better. Postdilation binocular visual acuity using the patients' usual correction was measured first in the office and then outdoors, both with the patient's back to and the patient facing the sun, with and without the aid of postmydriatic sunglasses. Twelve percent experienced disabling photophobia even with the use of postmydriatic sunglasses, with 3% having significant objective visual loss defined as 20/50 or worse. No objective visual loss was found in 30 controls examined outdoors before dilation, without sunglasses. We recommend that patients who have experienced significant photophobia with dilation in the past, or who have never before undergone dilation, make arrangements for transportation after a dilated examination.

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Effects of Routine Pupillary Dilation on Functional Daylight Vision

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• **The visual acuity of 100 patients between the ages of 16 and 66 years, seen for routine ophthalmologic examination, was measured before and after dilation. All patients had a predilation visual acuity of 20/40 or better. Postdilation binocular visual acuity using the patients' usual correction was measured first in the office and then outdoors, both with the patient's back to and the patient facing the sun, with and without the aid of postmydriatic sunglasses. Twelve percent experienced disabling photophobia even with the use of postmydriatic sunglasses, with 3% having significant objective visual loss defined as 20/50 or worse. No objective visual loss was found in 30 controls examined outdoors before dilation, without sunglasses. We recommend that patients who have experienced significant photophobia with dilation in the past, or who have never before undergone dilation, make arrangements for transportation after a dilated examination.**

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Although pupillary dilation is considered part of a complete routine ophthalmologic examination, to our knowledge no study has been carried out to determine its effect on functional daylight vision. A previous communication[1] has suggested that ophthalmologists could be held liable for injuries to both the patient and others if it could be established that an automobile accident was caused by visual impairment resulting from pupillary dilation. Most ophthalmologists have also had occasional patients complain bitterly about their postmydriatic photophobia and/or decreased vision, raising the question of the frequency and significance of such complaints.

For the purposes of this study, objective visual impairment was defined as a drop in binocular visual acuity to 20/50 or less based on the fact that this is below the legal minimum visual requirement for driving in many states. Subjective symptoms were recorded using an arbitrary scale of 1 (little or no discomfort) to 5 (totally disabling discomfort).

Our purpose, then, was to perform a clinical study to determine the effects of routine office pupillary dilation on objective and subjective functional daylight vision as defined above.

PATIENTS AND METHODS

Informed consent was obtained from 100 patients seen for routine ophthalmologic examination after the nature of the study was fully explained. A complete ophthalmologic examination, including a record of the patient's present prescription and manifest refraction, was performed. Before dilation, visual acuity was determined in each eye with the patient wearing his or her present correction, if any; this was repeated after dilation with both eyes open. Mydriasis was achieved by the instillation of two drops of 1% tropicamide and two drops of 2.5% phenylephrine in each eye. These data, as well as the patient's name and any ocular disease, were entered on a standard study form. The patients were then taken outside and asked to read a standard Snellen acuity chart at 6 m (20 ft), both facing the sun and with their back to the sun, wearing their usual correction. A hand-held photographic light meter was used, and readings were recorded in both positions at patient eye level. The vision was remeasured with the addition of commercially available disposable postmydriatic spectacles (which reduced light transmission to 13.2%), again facing and with their back to sun. Additional information obtained included the patient's subjective impression concerning the amount of discomfort experienced using a scale of 1 to 5 (with 1 indicating little or no discomfort, and 5 indicating severe discomfort) both without and with the use of postmydriatic sunglasses. Time of day, weather conditions (sunny, cloudy, overcast, or clear sky), iris color, and pupillary size indoors and outdoors were also recorded. Thirty randomly selected controls also were examined in a similar manner outdoors before dilation.

RESULTS

None of the 30 patients in the control group was objectively visually impaired without sunglasses. Only one had subjective discomfort (defined as a score of 3 or greater) facing the sun while 17 of 30 had discomfort with their back to the sun. Controls were not examined while wearing sunglasses because none believed they would be unable to drive without sunglasses even with their subjective discomfort.

All patients experienced significant subjective discomfort in sunlight after dilation (defined as a score of 3 or greater) without sunglasses (Fig 1). The distribution of subjective scores is shown in Fig 2. Twelve percent of

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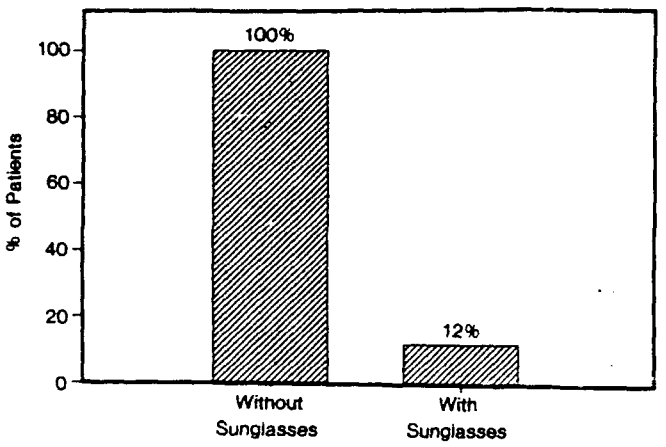

Fig 1.—Percent of patients with significant discomfort in sunlight (photophobia) after dilation.

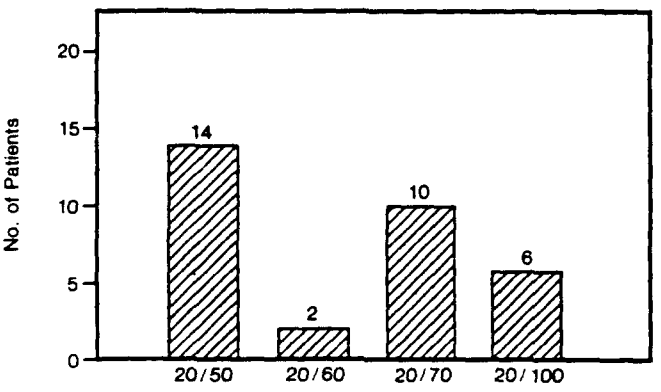

Fig 3.—Distribution of reduced visual acuities in sunlight in patients after dilation.

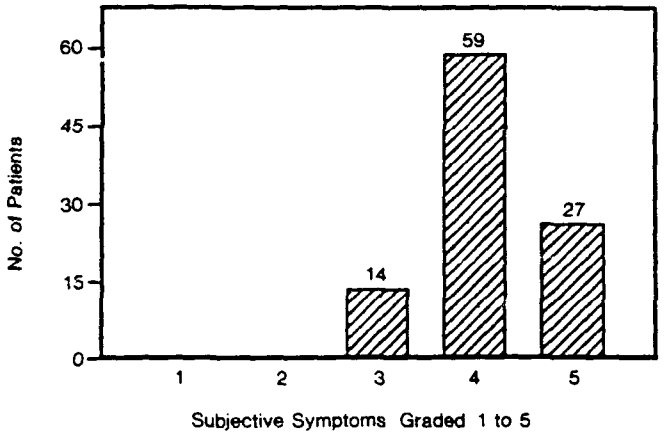

Fig 2.—Distribution of subjective discomfort (in sunlight) scores after dilation. On 1 to 5 scale, 1 indicates little or no discomfort; 5, totally disabling discomfort.

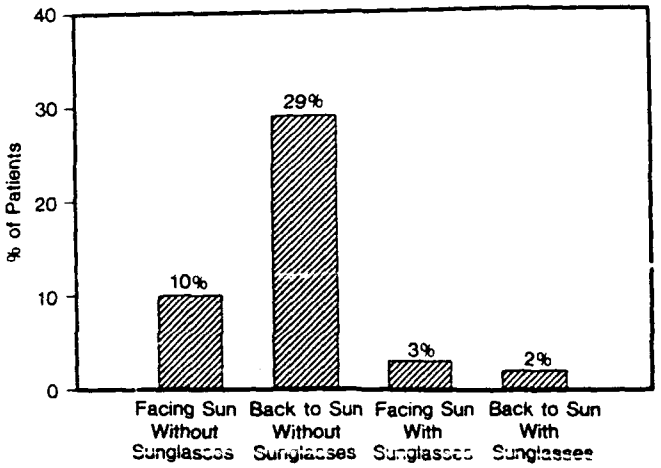

Fig 4.—Percent of patients with significant visual impairment (visual acuity, ≤20/50) after dilation.

the patients complained of significant subjective discomfort even with sunglasses and believed this discomfort would make driving difficult or impossible. Eighty-eight percent of the patients had light-colored irides.

Thirty-two of the patients were objectively visually impaired (defined as visual acuity of 20/50 or worse because this is below the minimum level of vision required by many states to operate a motor vehicle) after dilation in daylight without sunglasses. The distribution of visual acuities is seen in Fig 3. Interestingly, 29% of the patients noted a significant objective visual impairment with their back to the sun, whereas only 10% noticed significant visual impairment facing the sun without sunglasses (three of these patients had visual acuity better than 20/50 with their backs to the sun) (Fig 4). Three percent were objectively visually impaired after dilation even with the use of postmydriatic sunglasses. (Two had 20/70 and one had 20/50 visual acuity.) Only one patient experienced significant visual impairment in the office due to dilation alone. This patient was not hyperopic but had a moderate myopic astigmatism. Only one patient had a significant (+1.75) uncorrected hyperopia, but he still had a visual acuity of 20/30– following dilation.

Light meter readings varied from 1412 foot-candles (overcast, cloudy day) to 10850 ft-c (bright, cloudless Texas sky). Logically, one would expect a correlation between the brightness of the day and patient symptoms, but no unequivocal association was found (most readings, however, were taken under sunny conditions). Most subjects had pupillary diameters of 8 to 9 mm, but 11 patients had pupils less than 6 mm in diameter when examined in sunlight. Two of these patients still experienced objectively decreased vision without sunglasses. No correlation was evident between existing ocular disease and visual function in sunlight in the study group. We must note here, however, that 40 of these subjects were healthy US Air Force pilots without any ocular disease and that the remaining abnormalities in the nonpilots were limited to amblyopia, strabismus, and dry eyes, although one patient had early senile macular degeneration.

COMMENT

At the outset, it should be stressed that the objective and subjective criteria used in this study to define functional visual disability are to some degree arbitrary and may or may not correlate directly with an individual's ability to drive effectively. There are

many psychological as well as physiological variables that only can be evaluated by actually testing subjects while driving. Accepting this limitation, it is still important for the clinician to realize that routine pupillary dilation causes a decrement in objective and subjective visual performance.

The patient composition of this study was skewed toward a healthy, normal population with no cases of significant media opacity and only one patient with early senile macular degeneration. It is possible that inclusion of patients with moderate media opacities may have led to a higher percentage of cases with significant visual impairment after dilation due to light scatter and glare. In addition, only one patient with significant uncorrected hyperopia was identified. In a less-biased subject sample, we would expect a greater number of such patients and, in turn, possibly more with objectively reduced vision.

The presence of subjective photophobia after dilation is not surprising considering the fact that retinal illumination is related to the area of the pupil. For example, a pupil 9 mm in diameter would allow approximately 20 times the retinal illumination afforded by a 2-mm pupil. This illumination is reduced somewhat by the Stiles-Crawford effect,[2] but the increase in retinal illumination is still very significant. Increasing the pupil size at larger diameters also allows for a proportionally greater increase in retinal illumination. For instance, enlarging the pupil from 6 to 7 mm would contribute almost three times the additional light one would get from enlarging the pupil from 2 to 3 mm. Even when the Stiles-Crawford effect is considered, this would result in an increase in retinal illumination by a factor of about two. Of greater interest was the large number of patients who noted a significant objective impairment after dilation in sunlight. Two factors may account for this: First, it is known that very high luminances cause an unexplained reduction in acuity[3,4] even when the pupil is not dilated. Second, although visual acuity remains approximately constant in the photopic range with pupil diameters between 2.5 and 6 mm,[5,6] beyond these diameters chromatic and spherical aberrations begin to widen the point spread function with accompanying degradation in acuity.[7]

Surprisingly, we noted that the visual impairment was more prominent when the patients had their back to the sun, this being related to the production of glare from the acuity chart itself. For example, on a day when the ambient illuminance was 4800 ft-c, the chart illuminance with the subject's back to the sun was 3750 ft-c, while it was only 960 ft-c when the subject faced the sun and the chart was in the shade. Most determinations were done around midday; therefore, the direct glare of the early morning sun was not experienced. Unfortunately, most readings were taken at patient eye level, and the importance of obtaining light readings at the chart was not appreciated until most subjects had already been examined.

Of more concern, however, was the fact that 12% of the patients experienced functionally disabling subjective symptoms due primarily to photophobia even with the use of postmydriatic sunglasses. The use of a subjective scale of discomfort led to some apparent inconsistencies, with 17 controls rating their discomfort as 3 or greater but still feeling capable of driving, while 12% of the study patients, even with sunglasses, rated their symptoms 3 or greater and believed this would make driving difficult or impossible. It should be pointed out that most controls rated their subjective symptoms as 3, while most of the 12 study patients reported discomfort scores of 4 or greater. We believe the overlap in scores was practically resolved by the patients' subjective assessment of their ability to drive with this discomfort. Three percent of patients had an objective decrease in visual acuity to 20/50 and below even with sunglasses. While these subjective and objective findings occurred most commonly in patients with light irides, they were also found in patients with dark-brown irides. As an example, two of the three subjects with significant visual loss even with sunglasses had green eyes and one had dark-brown eyes.

If we relied on the postmydriatic vision in the office as an indicator of functional ability as defined in this study, only one case would be identified of the 12 subjectively and three objectively affected in sunlight wearing sunglasses. Because it cannot be predicted beforehand which patient will have difficulty either subjectively or objectively after dilation, all new patients should be warned that dilation may cause significant discomfort in sunlight even with sunglasses. If patients have experienced significant photophobia or decreased vision with dilation in the past or have never before undergone dilation, we suggest, based on our findings, that they should make arrangements for transportation after routine office dilation or wait until recovery of pupillary constriction.

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